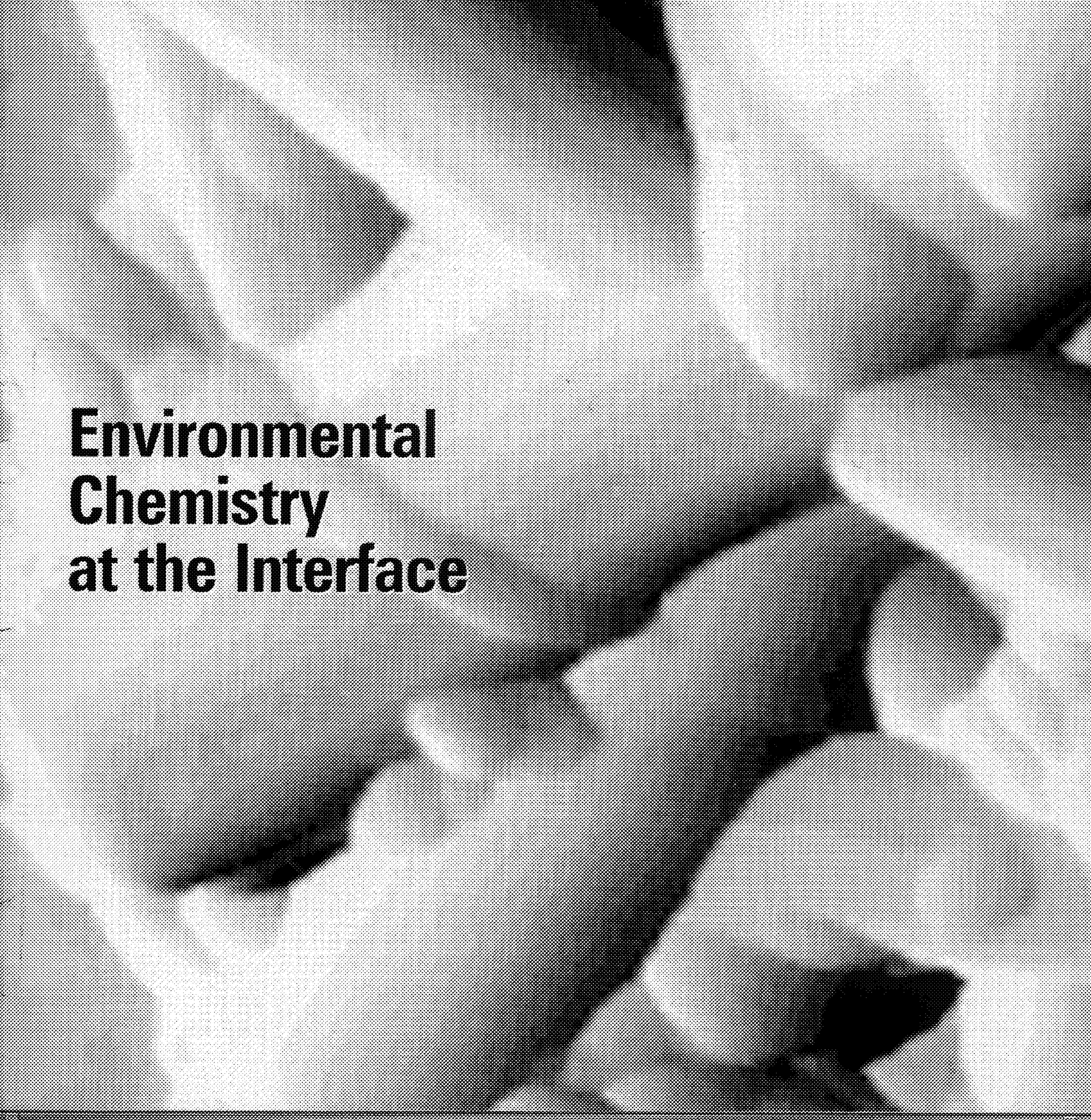
OCTOBER 1, [illegible]

ENVIRONMENTAL SCIENCE & TECHNOLOGY

News & Research Notes



Environmental Chemistry at the Interface

AVAILABLE ON THE WEB http://pubs.acs.org

Rotating ion-exchange system removes perchlorate

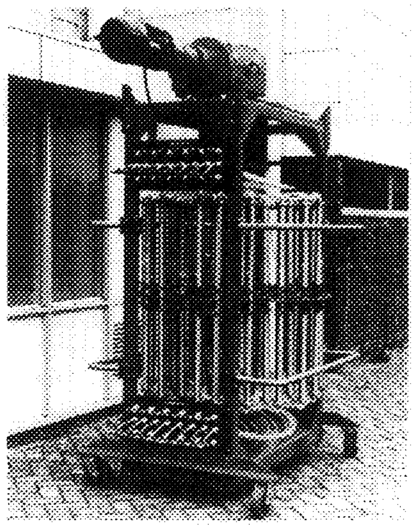
In July and early August, researchers demonstrated an effective method for remediating drinking water contaminated with low levels of perchlorate, a rocket-fuel waste. It is one of at least 10 research efforts for treatment of perchlorate-contaminated water and is likely to be among the first to become commercially available.

Developed by Calgon Carbon Corporation of Pittsburgh, Pa., the technology relies on an ion-exchange method originally used to remove nitrate from waste streams. Unlike conventional "fixed bed" ion exchange systems, Calgon's system uses a continuously rotating countercurrent process that results in far less brine waste, according to Raman Venkatesh, senior research engineer at Calgon. It has yet to be determined whether the method will prove economical for use by drinking water utilities.

At least 10 states have drinking water supplies known to be contaminated by perchlorate, released during routine maintenance of the country's missile and rocket inventory (*ES&T*, May 1, 1998, p. 210A). The contamination could prove to be more widespread, as perchlorate-containing fuel components have been shipped to over 150 facilities located in 37 states, said Kevin Mayer, a project manager for EPA's Region 9, which includes California and Nevada, where extensive contamination has been discovered.

California has set a provisional maximum perchlorate contaminant level of 18 micrograms per liter (µg/L) (which is equivalent to 18 parts per billion) for drinking water, and EPA's provisional national guideline calls for levels between 4 and 18 µg/L to avoid health risks. The agency anticipates reassessing the national guideline this fall after reviewing data from eight toxicology studies being conducted by the Air Force, said Michael Osinski, team leader for EPA's Office of Groundwater and Drinking Water.

This summer's pilot-scale demonstration was funded by the Main San Gabriel Basin Watermaster at a Superfund site in southern California. Calgon's ion-exchange separation technology, which incorporates a resin effective for perchlorate removal, was used to treat incoming water con-



An ion-exchange system like this one developed by Calgon Carbon Corporation was successfully used to remove low levels of perchlorate from water. (Courtesy Calgon Carbon Corporation)

taining between 20 and 75 µg/L of the contaminant. It reduced the perchlorate concentration to nondetectable levels (below 4 µg/L), Venkatesh said.

During the five-week demonstration, engineers minimized the amount of wastes from the brine solution used in regenerating the ion-exchange process. Conventional ion-exchange processes typically produce between 2 and 5% brine waste, by volume. By optimizing the technology, Venkatesh's team reduced Calgon's waste to between 0.5 and 1% of the incoming volume without harming process effectiveness. In a second pilot-scale test expected to start by September, engineers plan to demonstrate a method for eliminating the waste material from the brine, so it can be recycled, according to Venkatesh.

Three promising approaches. Continuous ion-exchange processes like Calgon's, together with biological treatment and reverse osmosis, constitute the three most promising technologies for removing perchlorate from drinking water, according to Frank Blaha, project manager for the American Water Works Association's Research Foundation (AWWARF). Though perchlorate is a highly oxidized compound, and conventional wisdom holds that it would react with anything in the environment, initial treatment studies showed its kinetics to be unfavorable for reacting, explained Mayer. For this reason, ion-exchange processes and reverse osmosis are obvious treatments because they deal well with salts and dissolved solids, Mayer explained. However, Osinski noted that both of these treatment techniques can increase the corrosivity of the water. Biological treatment is appropriate for remediating perchlorate because a catalyst appears necessary to make the contaminant react, and biological systems are superb catalysts, Mayer said.

Concern over the lack of cost-effective methods for treating water contaminated with low levels of perchlorate led Congress to earmark $2.1 million for research in 1998. The funds are being administered by AWWARF, which was expected to make final decisions about which treatment research proposals to support in August. One ion-exchange, one reverse osmosis, and two biological treatment methods will be funded, according to Blaha.

A promising treatment evaluation of reverse osmosis membrane technology was completed last May, when researchers at Harvey Mudd College wrapped up their laboratory-scale tests using the technology to remove between 20 and 1000 µg/L of perchlorate from contaminated wa-

0013-936X/98/0932-454A$15.00/0

ter. They reported removal efficiencies of upward of 97%. In addition to perchlorate, the technology removes organic compounds, dissolved solids and salts—the latter being particularly valuable in California, where bromate is a concern—said Jeanne-Marie Bruno, associate director of water quality for the Metropolitan Water District of Southern California, which funded the research. The downside of the reverse osmosis process is that its brine wastes require disposal, admits Bruno. Also, the water requires pretreatment, and energy must be used to push it through the membranes, she said.

Many biological treatment proposals. Because biological treatment is expected to be one of the most cost-effective methods for removing perchlorate from drinking water, AWWARF received nine biotreatment research proposals. Among them is a technology developed by Bruce Logan, an environmental engineer at The Pennsylvania State University. In June, Logan reported that his technology, which employs a mixed culture of anaerobic bacteria, could cleanse water containing 20 milligrams per liter of perchlorate and reduce the contaminant to undetectable levels. Those results were achieved in the laboratory, using artificially contaminated water enhanced with nutrients, then percolated through 14.2-centimeter-long columns filled with sand. By July, Logan was testing the method in 2.5-foot-long sand columns analogous in size to the pipes used in drinking water treatment plans.

There is likely to be philosophical resistance among drinking water providers to using biological treatment, cautioned Mayer: "The whole history of drinking water treatment relies upon keeping bacterial growth to a minimum. Taking clean water and adding microbes is basically turning it into wastewater."

Because the federal government and affected water suppliers have placed a high priority on finding ways to treat perchlorate-contaminated drinking water, these technologies are being developed "pretty quickly," Mayer said. But Osinski said that it's still unclear how long it will be before cost-effective technologies are available for removing low levels of perchlorate from drinking water. —KELLYN S. BETTS